MSFC ANALYSES OF ISS AURORAL AND SOLAR ARRAY CHARGING ENVIRONMENTS AND EFFECTS

5th Space Weather & NASA Robotic Mission Operations Workshop

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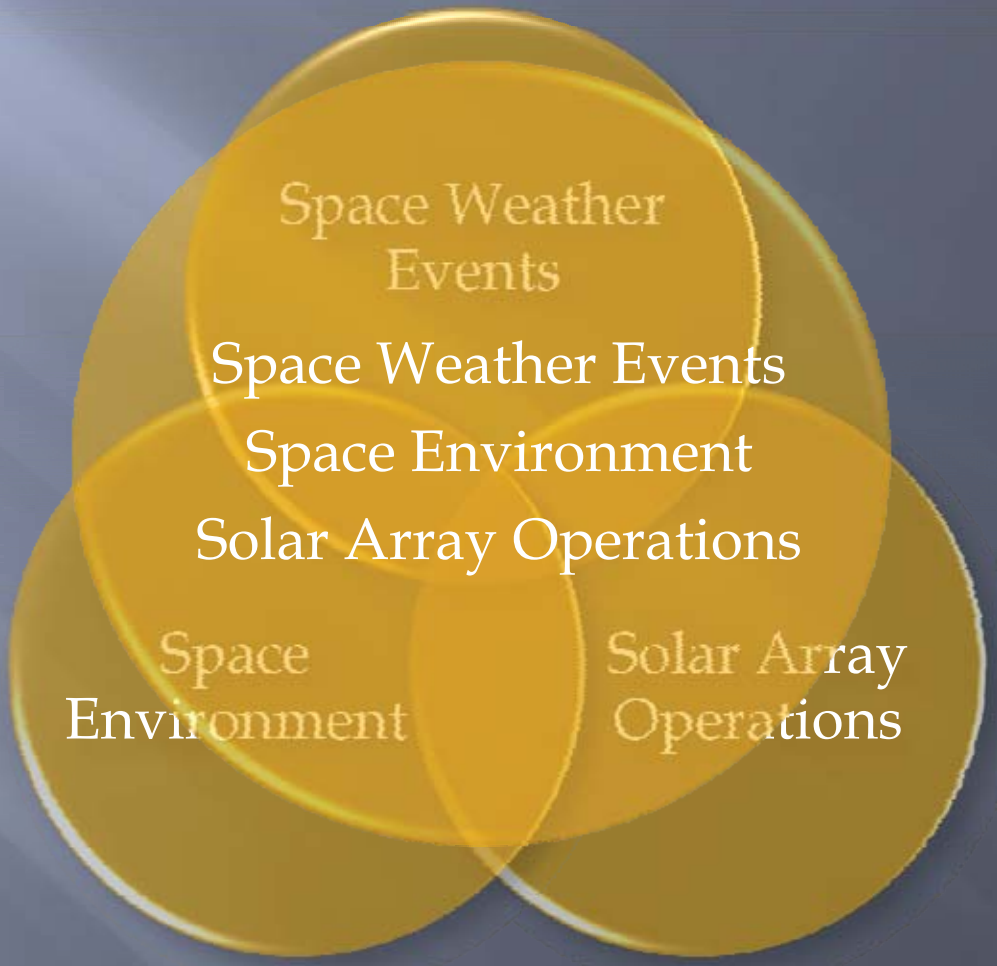
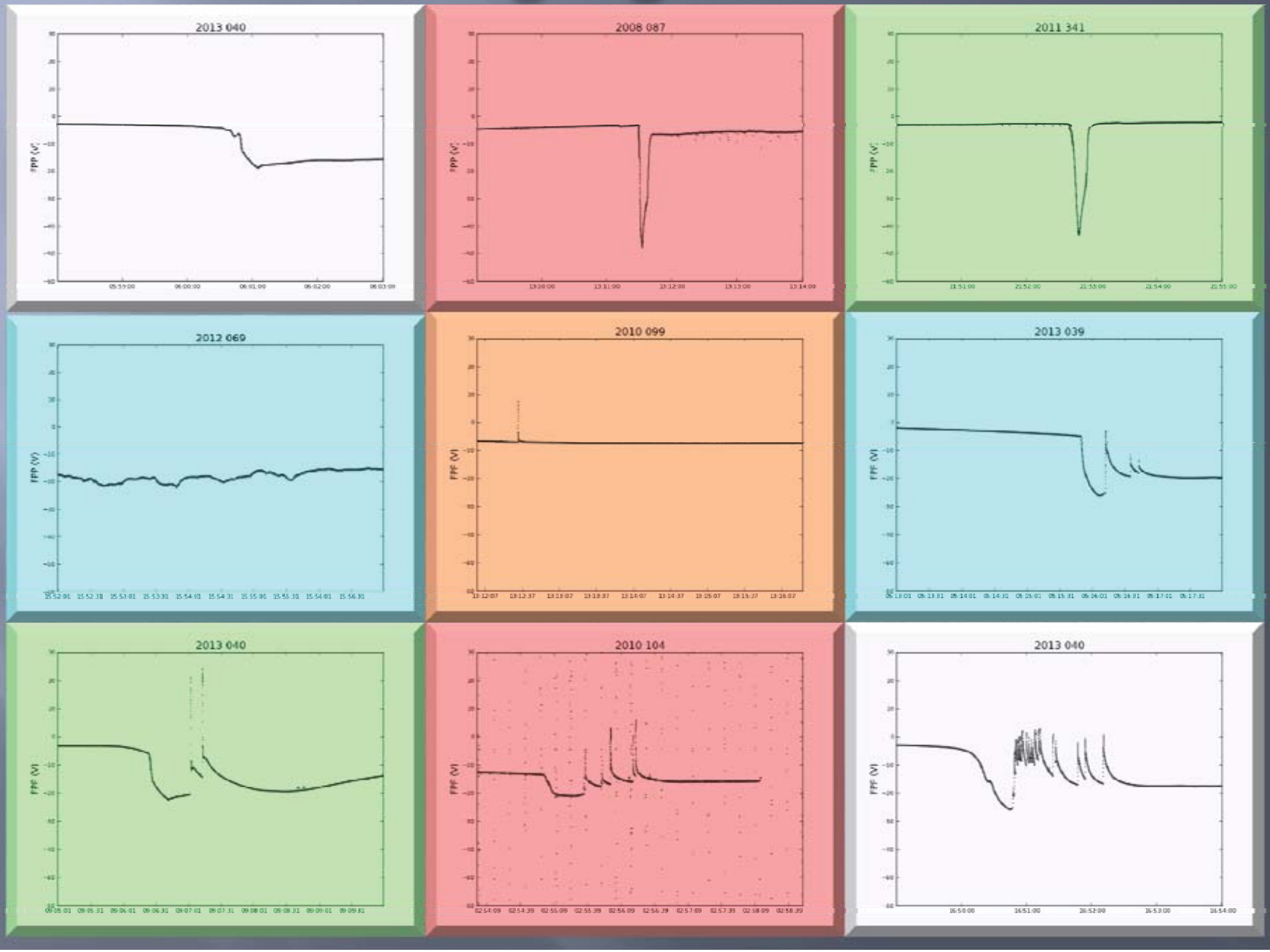
Environment versus Operations



Charging Mosaic



Floating Potential Measurement Unit (FPMU)

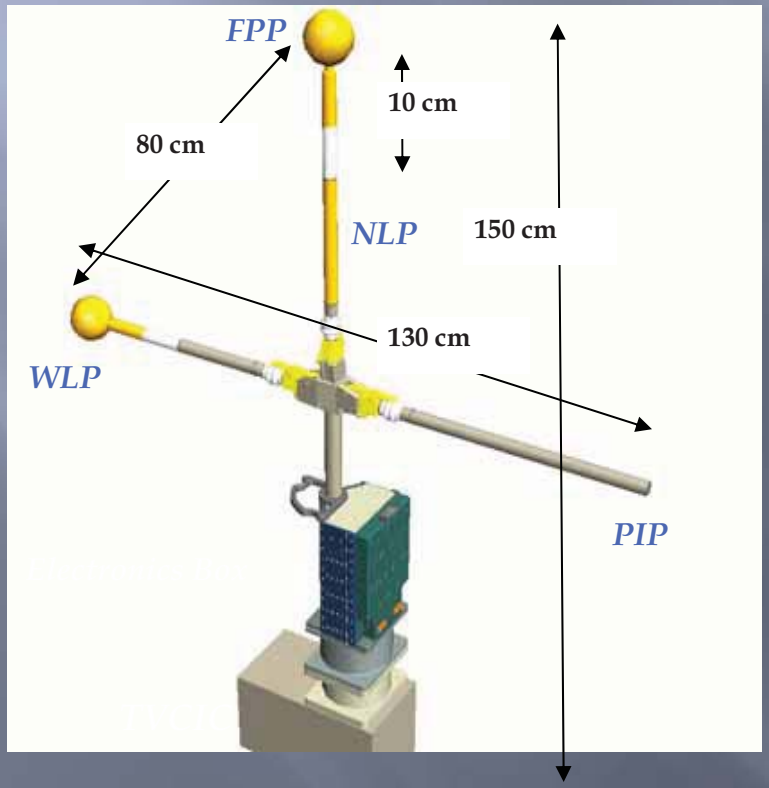
Instruments

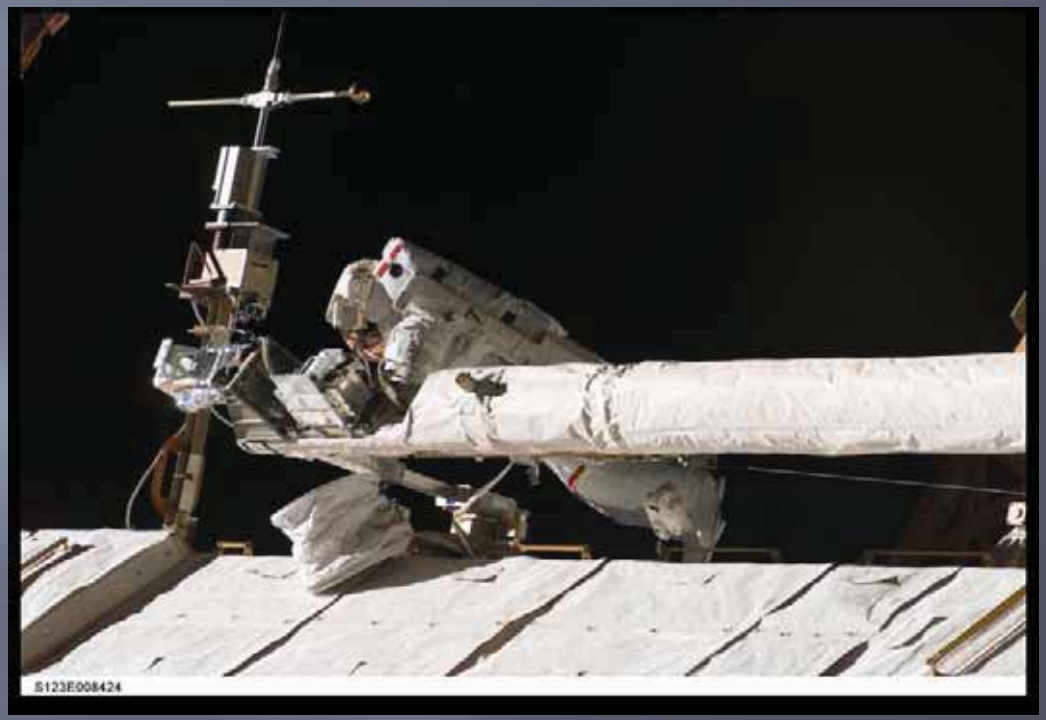
FPP: Floating Potential Probe

WLP: Wide-sweep Langmuir Probe

NLP: Narrow-sweep Langmuir Probe

PIP: Plasma Impedance Probe

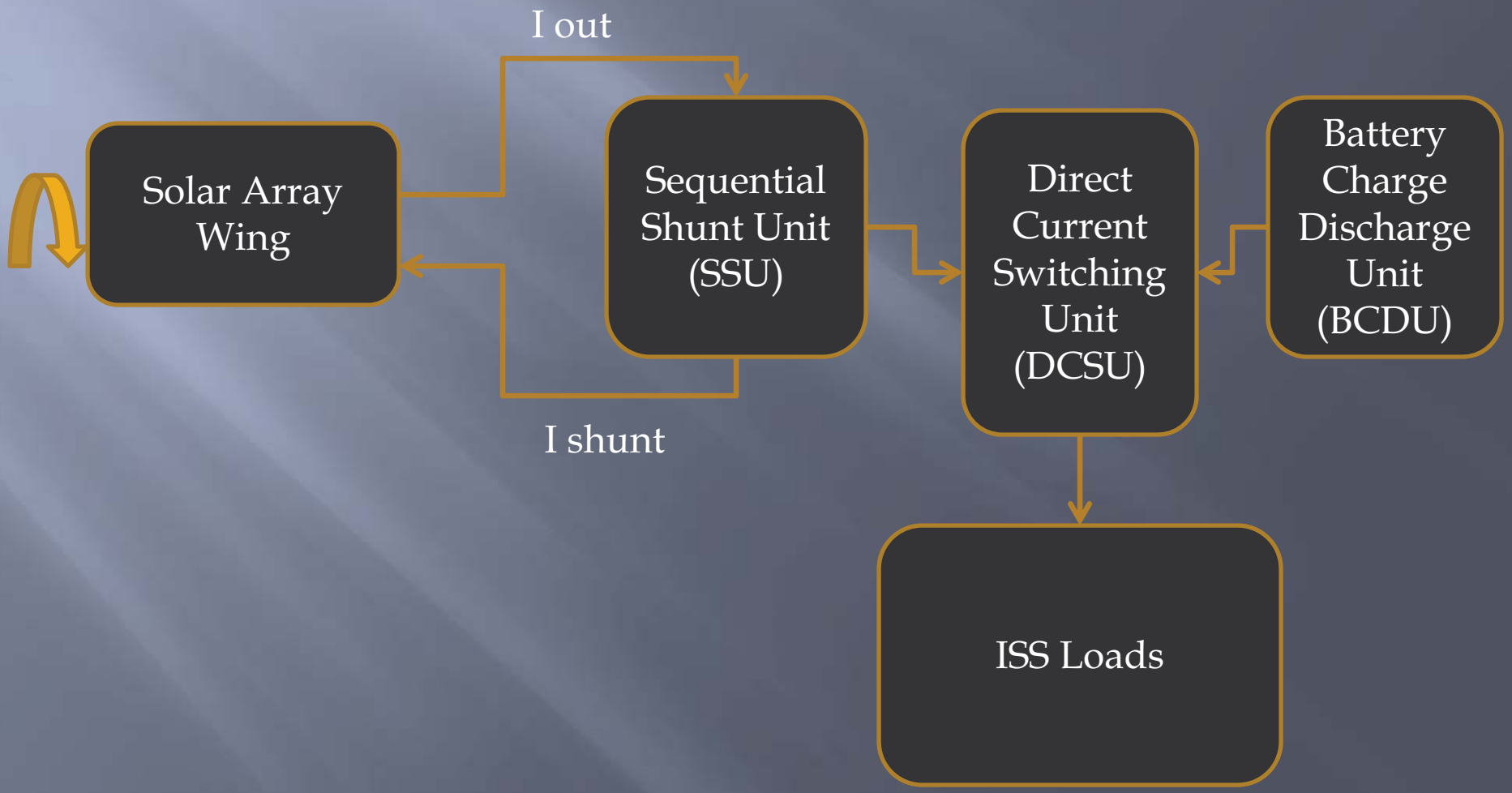




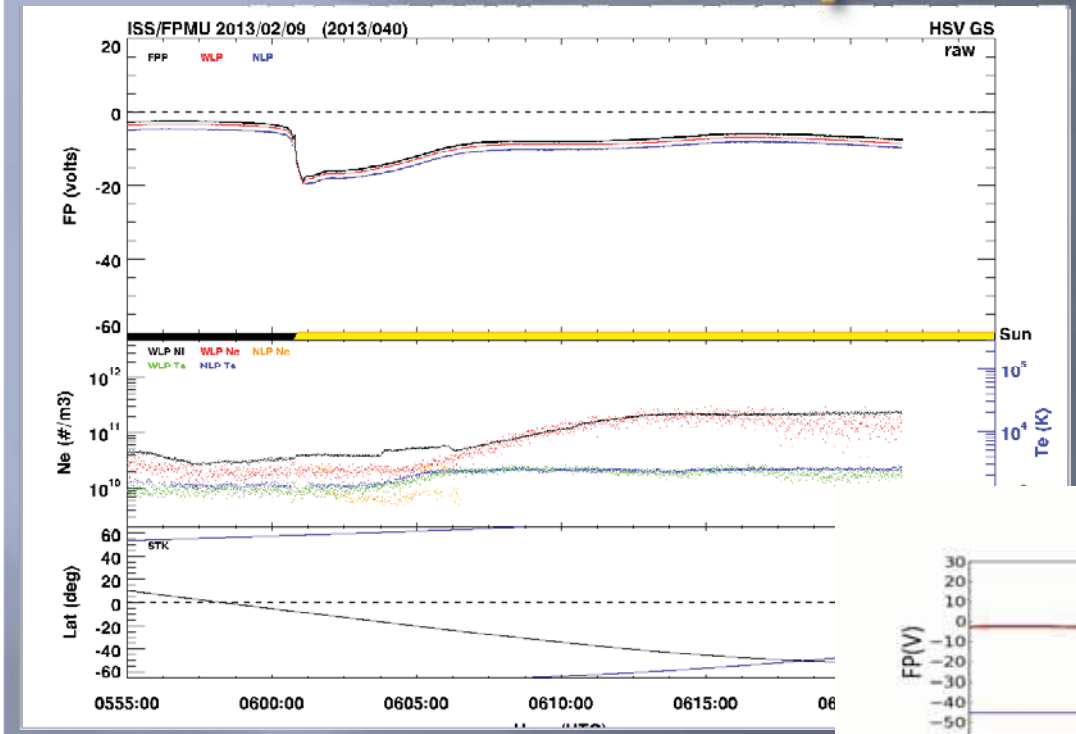
Sensor	Parameter	Rate (Hz)	Effective Range
FPP	V_F	128	-180 V to +180 V
WLP	N T_e V_F	1	10^9 m^{-3} to $5x10^{12}$ m^{-3} 500 K to ~10,000 K -20 V to 80 V
NLP	N T_e V_F	1	10^9 m^{-3} to $5x10^{12}$ m^{-3} 500 K to ~10,000 K -180V to +180 V
PIP	N	1	$1.1x10^{10}$ m^{-3} to $4x10^{12}$ m^{-3}

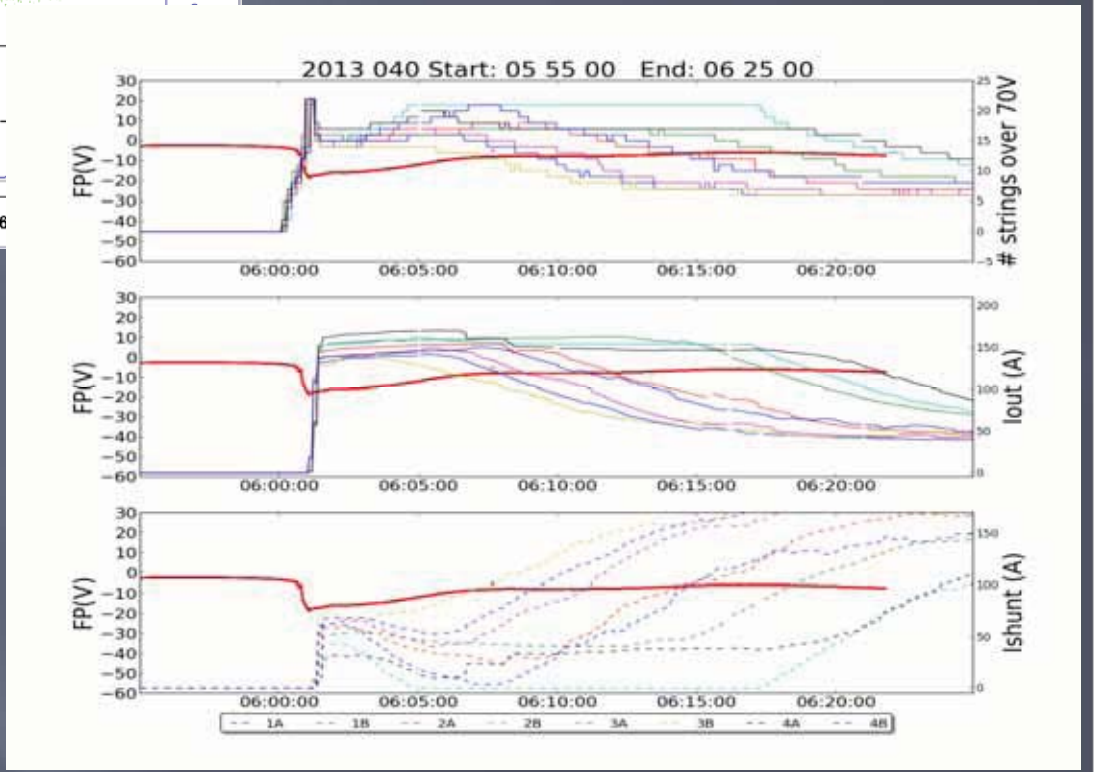
[*Wright et al.*, 2008; *Barjatya et al.*, 2009]

ISS Solar Array Data

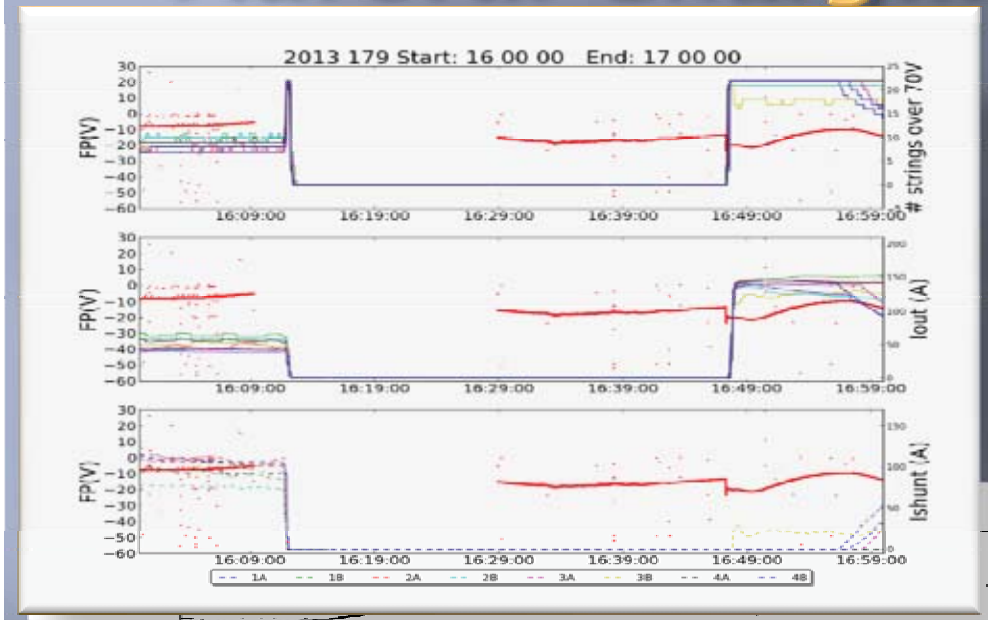


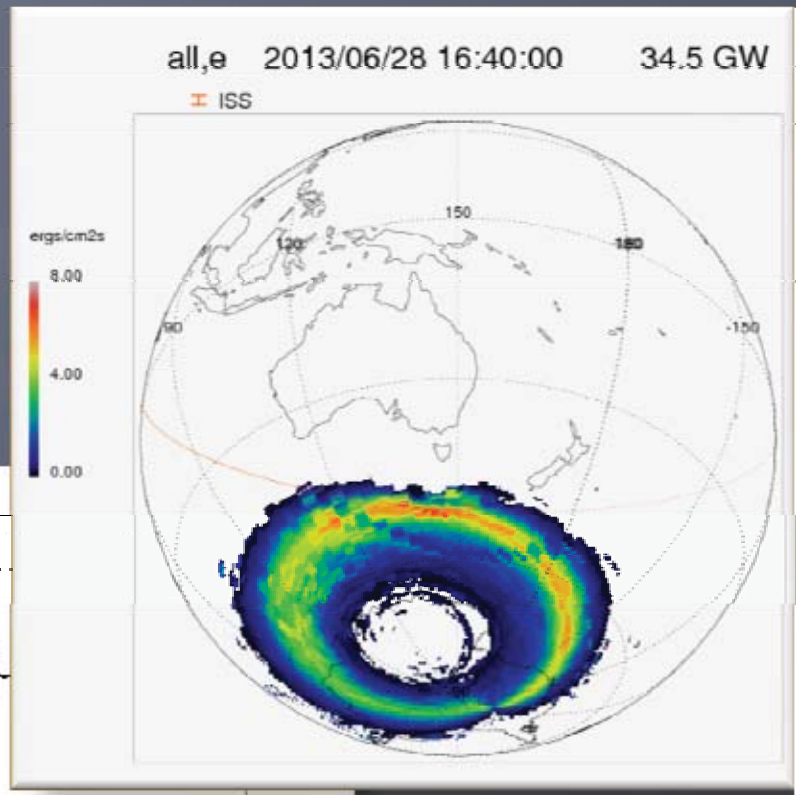
Normal Eclipse Exit Charging

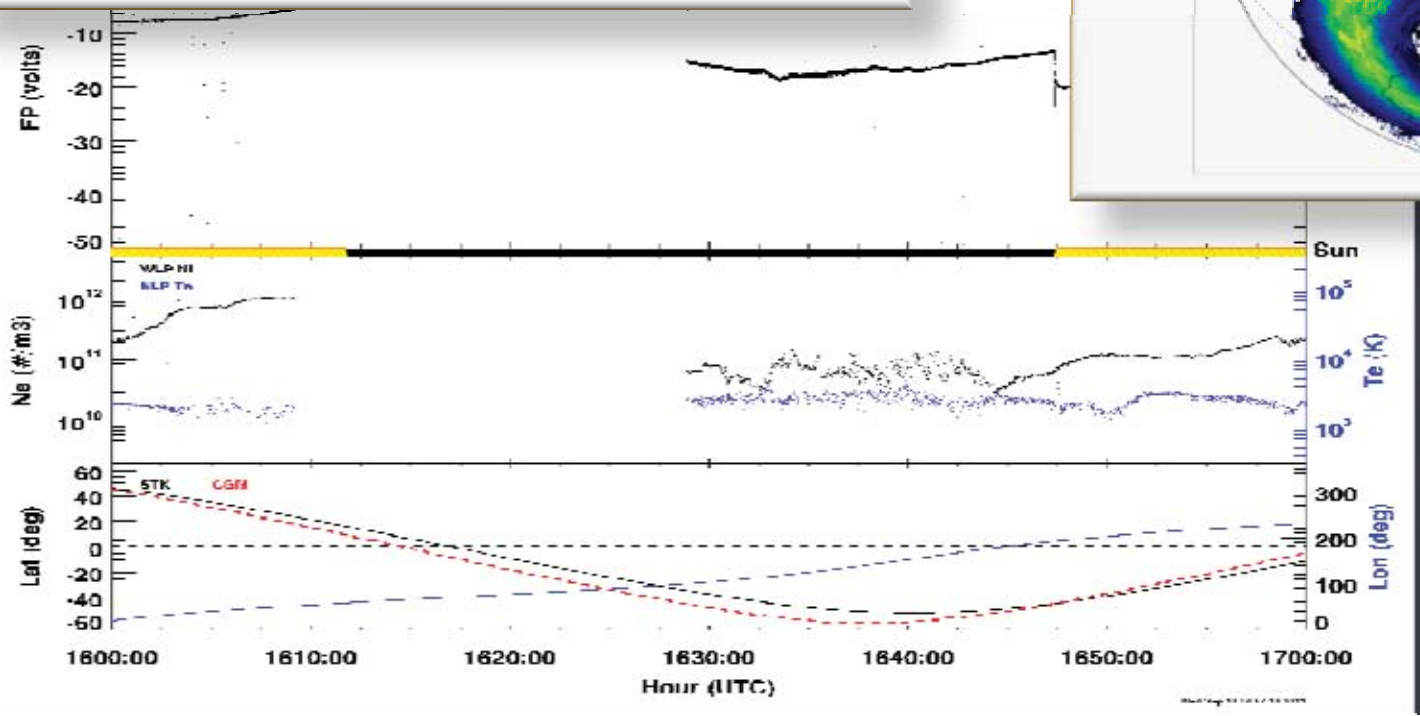




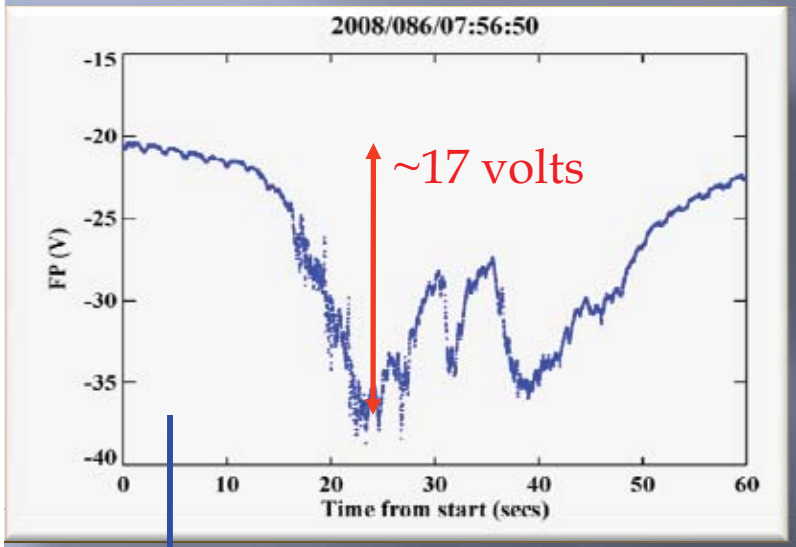
Auroral Charging June 28 2013

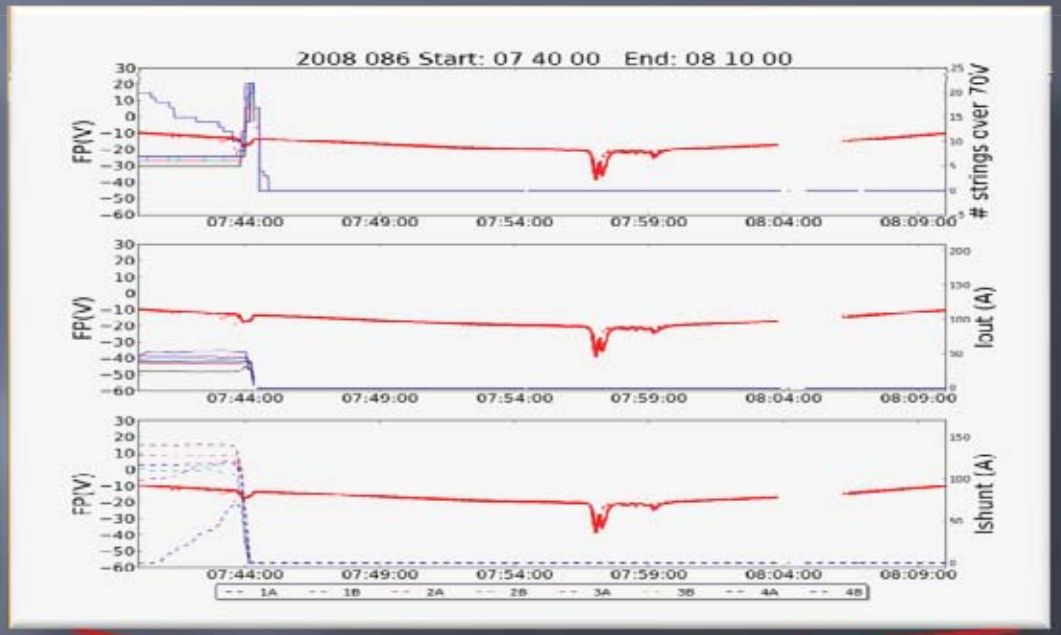




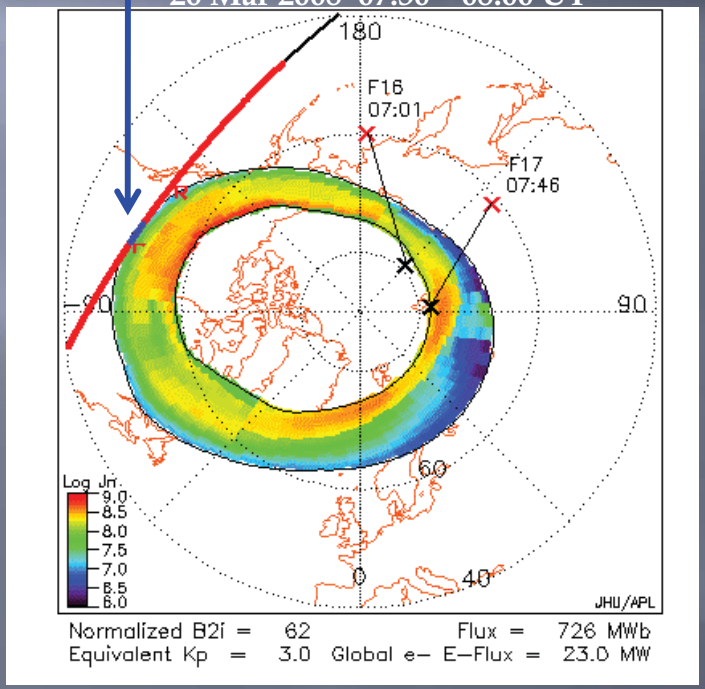


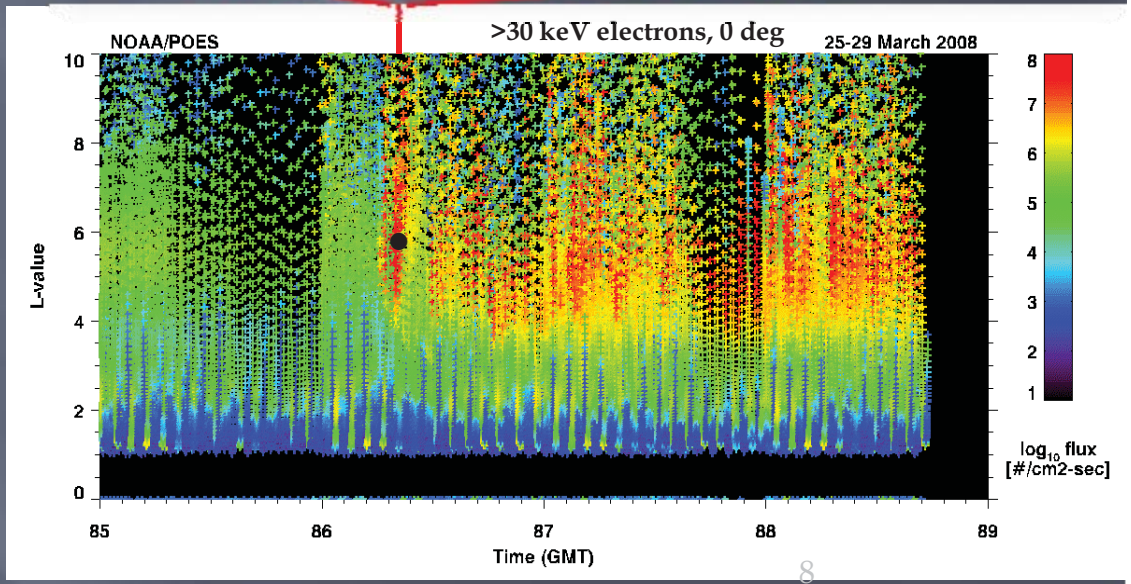
Auroral Charging March 26 2008





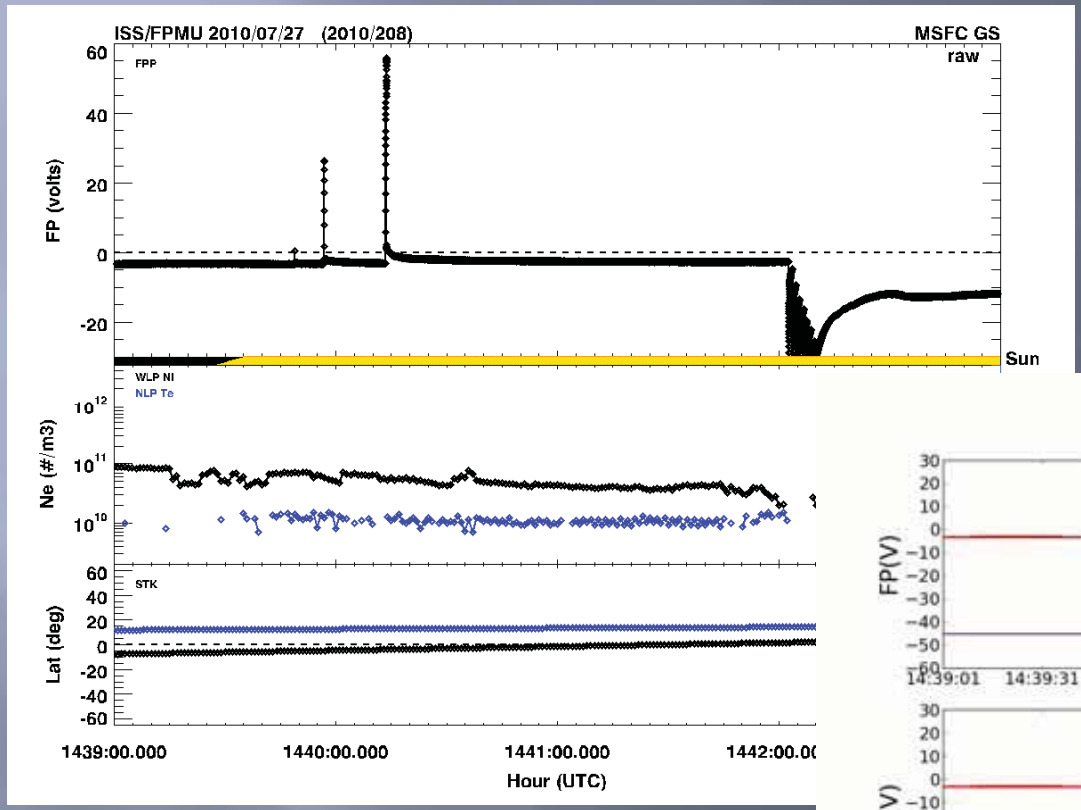
26 Mar 2008 07:30 – 08:00 UT



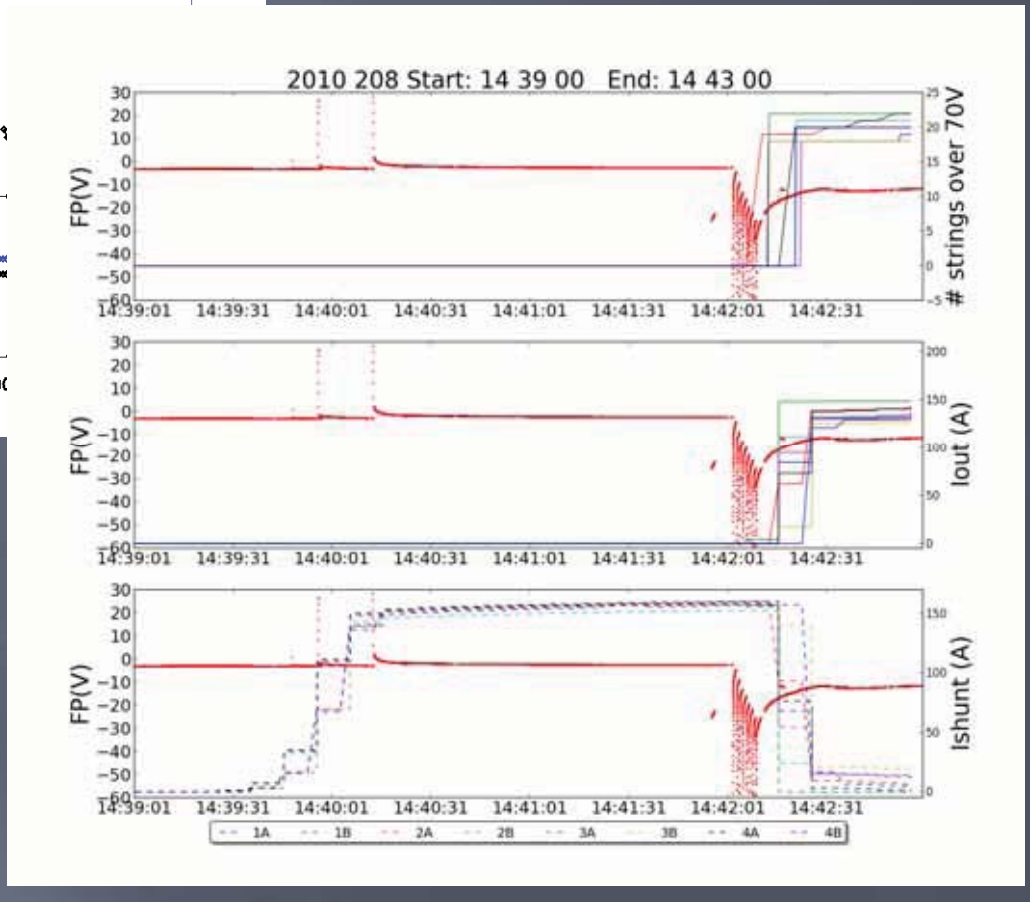


[adapted from *Craven et al.*, 2009]

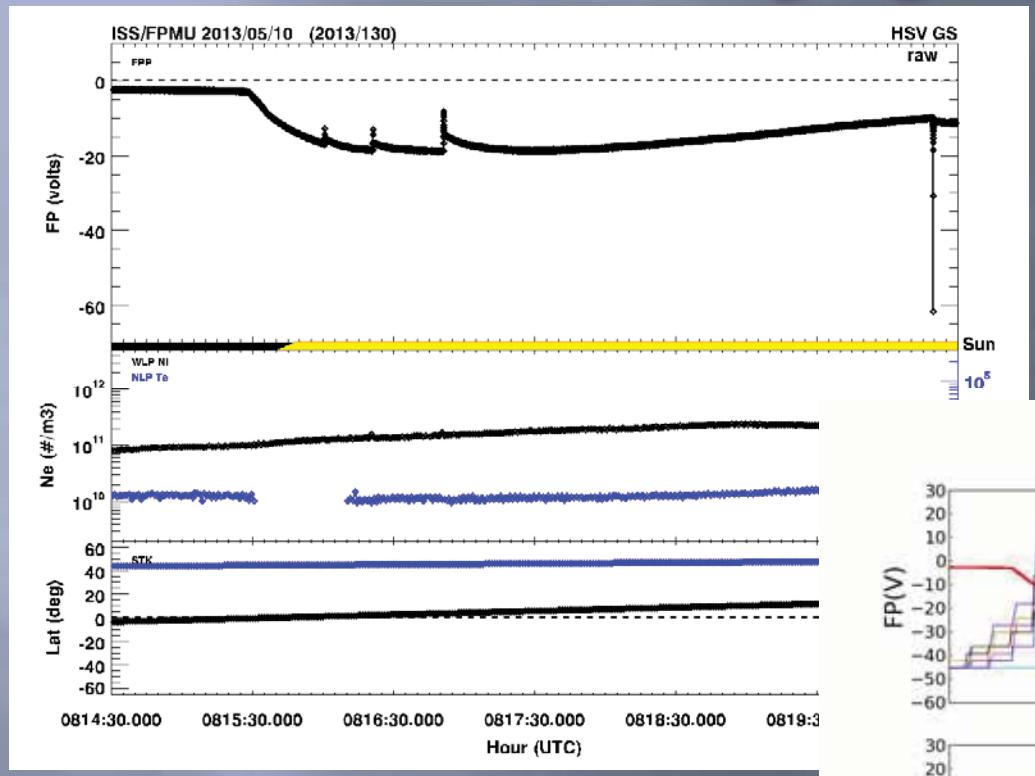
Positive Charging Peaks

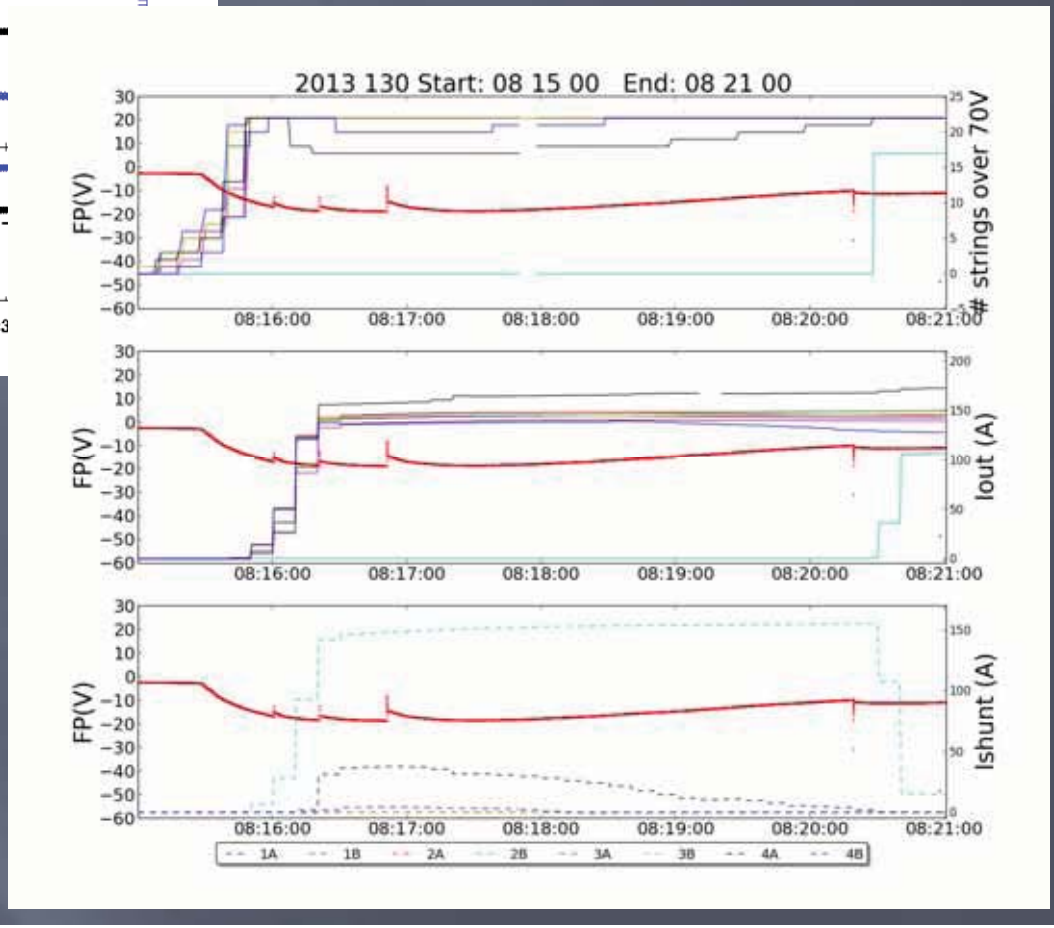


All Arrays Shunted at Eclipse Exit



Normal Charging + Positive Peaks





Summary

- Analysis on-going to differentiate charging due to environment and operations
- Analysis requires a combination of FPMU data, ISS systems data, and other data sources.
- Results will be important for current ISS operations as well as future spacecraft programs

Backup

Applicable ISS Data

- Shunt currents
- SSU output current
- SSU Shunt Currents
- SSU/BCDU regulation handover
- Solar Array String Voltage
- BGA, SARJ Angles/Biasing

Types of ISS Charging

- Normal and Rapid Eclipse Exit
- Magnetic Induction
- Eclipse Entry
- Auroral
- Equatorial Depletions
- Docked Vehicles
- Positive Peaks
- Combination Peaks/Multi-Peaks
- Extreme Rapid Events (Shunt Experiments)

Floating Potential Measurement Unit (FPMU)

- **FPMU instrument suite provides redundant measurements of plasma environments and vehicle charging along ISS orbit:**
  - Ionosphere electron density, electron temperature, and ion density (WLP, NLP, PIP)
  - ISS floating potential and plasma potential (FPP, WLP, NLP)
  - ISS floating potential response to variations in space plasma environment (FPP, WLP, NLP)
  - Charging behavior due to electrical power system interactions with plasma environment (FPP, WLP, NLP)
- **ISS engineering applications:**
  - Characterizing US high voltage (160 V) solar array interactions with ionosphere plasma
  - ISS charging due to visiting vehicles
  - ISS charging due to energetic auroral electrons during geomagnetic storms
  - US and Russian extravehicular activity (EVA) plasma hazard support
  - Anomaly investigations
- **Science applications:**
  - Collaborative ionospheric research with other spacecraft and ground based facilities
  - Incoherent scatter radar World Day periods
  - ISS payload science support
  - Validating empirical and physics based ionosphere models